Pearson
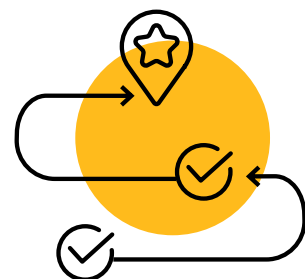
Learning Design Principles
Purposeful Design

Personalized Learning & Adaptive Systems
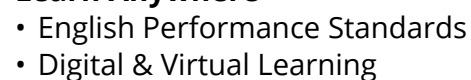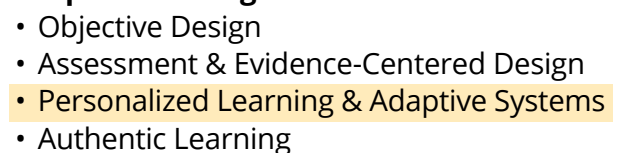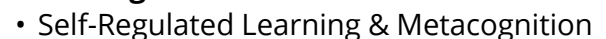
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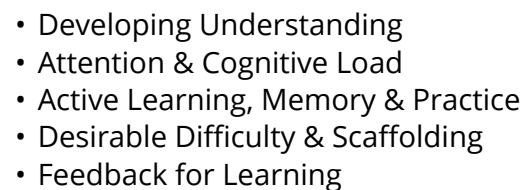
What are Pearson's Learning Design Principles?

Our Learning Foundations describe the optimal conditions for learning and reflect the learner experience we hope our products will create. We do this by incorporating our Learning Design Principles.

Each of our Learning Design Principles goes into detail about a key principle, supporting product design and marketing by describing:

- the research that informs the principle
- why it matters in learning
- how we can apply it in practice

Our portfolio of Learning Design Principles will continue to grow over time.

Welcoming Experience
- Motivation & Mindset
- Social & Collaborative Learning

Minds in Mind
- Developing Understanding
- Attention & Cognitive Load
- Active Learning, Memory & Practice
- Desirable Difficulty & Scaffolding
- Feedback for Learning

Learning Behavior
- Self-Regulated Learning & Metacognition

Purposeful Design
- Objective Design
- Assessment & Evidence-Centered Design
- Personalized Learning & Adaptive Systems
- Authentic Learning

Learn Anywhere
- English Performance Standards
- Digital & Virtual Learning
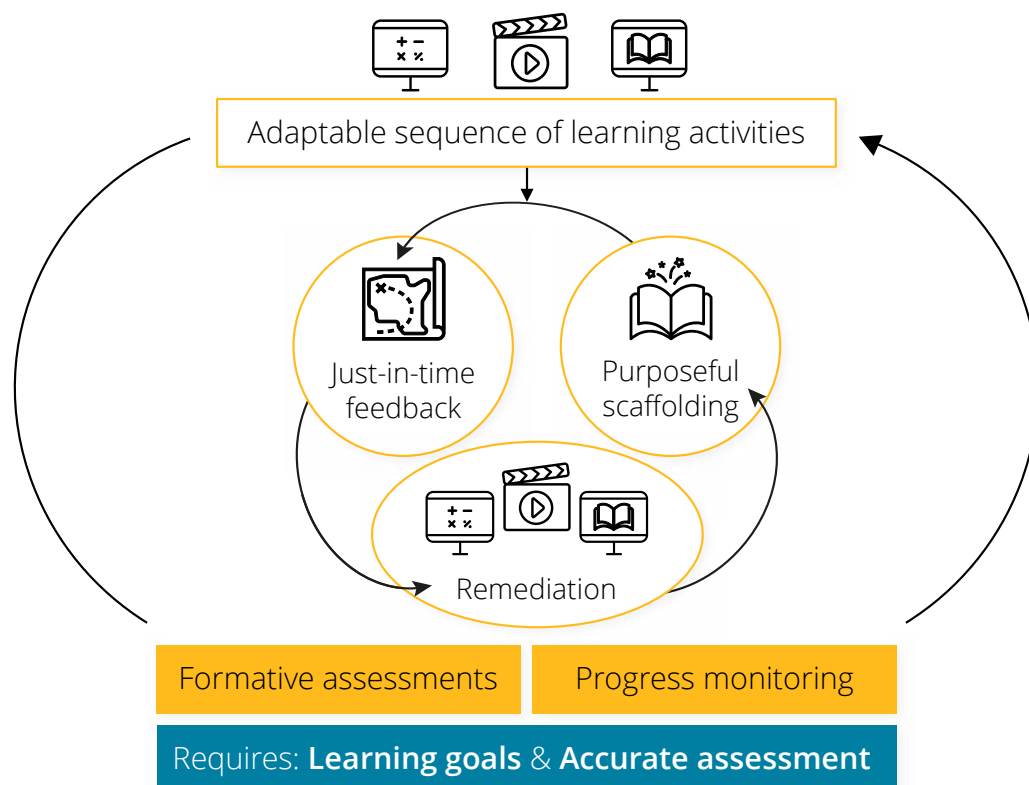
Personalized Learning & Adaptive Systems

Learners can struggle to understand where they are in their learning journey, what their unique needs are, and where to focus to achieve their goals.

How can more personalized experiences help learners achieve more?

Personalized learning is the customization of components of a learning experience, such as instruction and assessment.

Digital personalized learning attempts to scale up the benefits of one-on-one human tutoring. In digital environments, personalization is usually achieved with adaptive systems. **An adaptive system is a system that changes its behavior in response to its environment, informed by data captured from the environment.**

Adaptive systems can provide personalized learning at scale by

Adaptable sequence of learning activities

Just-in-time feedback

Purposeful scaffolding

Remediation

Formative assessments

Progress monitoring

Requires: **Learning goals** & **Accurate assessment**

assessing learners' current skills and knowledge, providing feedback and content, and then consistently monitoring progress using learning algorithms that provide real-time updates and the necessary tools to improve student learning. The result is a supercharged learning experience that focuses and adjusts with learners throughout the experience.
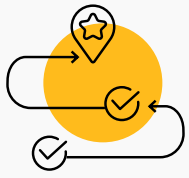
Why it matters

When learning experiences are personalized, learners tend to be more engaged with the content, learn more effectively and efficiently, and experience opportunities to develop self-regulated learning skills.

When learning experiences use adaptive systems, we can provide personalized learning at scale; learning can be self-paced, flexible, with immediate feedback, scaffolding support, and just-in-time delivery; and learners are encouraged to take ownership of their learning.

Impact

When we successfully incorporate this principle into learning experiences, we can have an impact on these learner outcomes:

- learners have a positive learning experience because adaptation provides the right content and experience at the right time
- learners are motivated and enjoy learning because they have opportunities to exercise choice

- learners use good study habits, apply appropriate strategies and help-seeking behaviors, persist, and self-manage because they are supported by scaffolding, hints, and nudges
- learners achieve proficiency on key objectives efficiently, because the learning experience assesses their proficiency and offers content at the right difficulty level

Personalized Learning & Adaptive Systems
The big ideas

1 There are degrees of personalization, and **some methods are more effective** than others. Compared to experiences that aren't personalized at all, personalized learning environments can improve learning.

I need the right learning experience at the right time.

2 *I can't do this easily, but I will be able to figure it out with hints and support.*

Learning experiences that are **personalized to learners' knowledge and skills** are more efficient and effective than learning that is not.

I am interested — and my knowledge about the topic might help me think about the problem.

3 Learning experiences that are **personalized to learners' interests** can support greater motivation and learning.

4 Personalizing content to match learning styles **does not** support learning or motivation.

I think I'm an auditory learner, but that does not mean I will learn more from an audiobook than an e-text.

I still learn something even when I go in feeling down or distracted.

5 Personalizing content according to **non-cognitive factors**, such as affective states and identity, can sometimes improve learning.

6 Providing learners with **guided choice** in their learning experience can enhance motivation, autonomy, and self-directed learning.

I feel in control of my learning through the choices I am making, but I have guidance to make effective choices.

Degrees of personalization

There are degrees of personalization, and some methods are more effective than others. Compared to experiences that aren't personalized at all, personalized learning can improve learning.
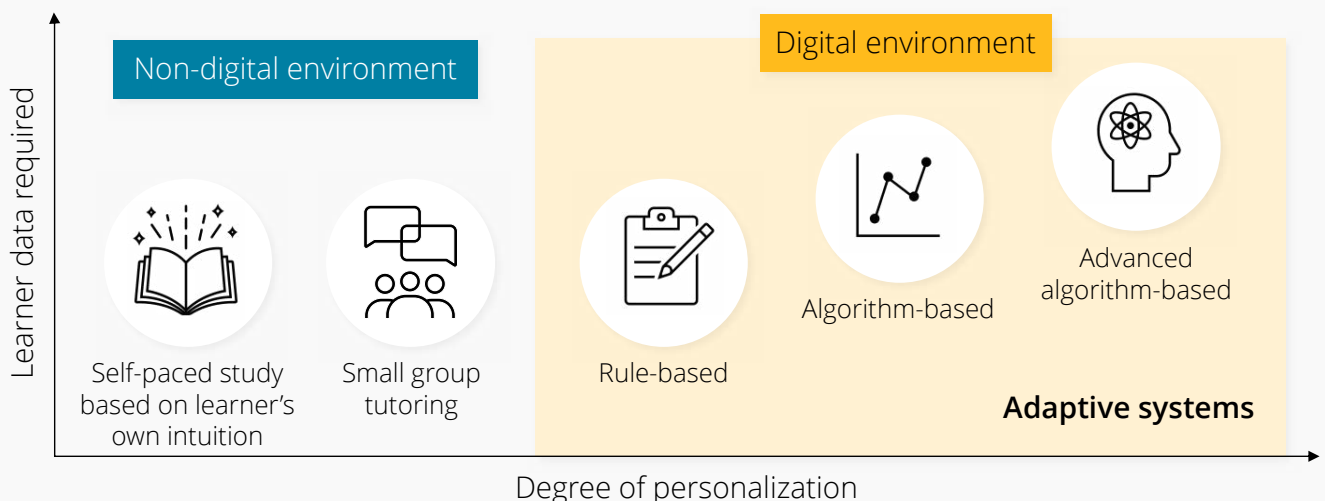
What it feels like for learners

I need the right learning experience at the right time.

There are different types and degrees of personalization. These vary based on the capabilities and constraints of the adaptive system being used.

- **Rule-based** personalization uses a decision tree or set of rules leading to several different pre-set learning paths.

  For example: Learners complete a pre-test to identify their current learning needs. Based on the result, they are each assigned to one of four pre-determined learning experiences, each of which comes with a different level of content and support.

- **Algorithm-based** personalization periodically updates the learning experience based on data collected at various intervals during the experience itself.

  For example: A check-in test midway through a chemistry lesson determines that a learner has grasped the pH scale, but is still struggling with acid–base reactions. The system adapts the learning path to provide more instruction and practice on acid–base reactions.

Personalized learning continuum

Non-digital environment

Digital environment

Learner data required

Self-paced study based on learner's own intuition

Small group tutoring

Rule-based

Algorithm-based

Advanced algorithm-based

Adaptive systems

Degree of personalization

- **Advanced algorithm-based** personalization uses learner data collected and updated in real-time to change and adjust the learning experience as it happens.

  For example: A system captures behavioral, assessment, and learner metrics in real-time and uses them to inform the order in which activities appear to each learner. The system could take the form of a game, simulation, or highly interactive learning experience.

Personalization can happen at different places in the learning sequence.

- **Lesson-level** personalizes the selection of learning paths, interest customization, or topic sequencing (e.g., course suggestions or branching). It is based on individual or aggregate historical learner data.

- **Task-level** personalizes the next task/problem, or the instructional support within specific steps of the task/problem (e.g., feedback at different problem-solving steps). It is based on individual learner data.

What it means for designing learning experiences

- Create domain and learner models to identify what level learners are at and what content is appropriate
- Make sure you have enough data about the learner for accurate personalization
- When modeling learners' knowledge, acknowledge that understanding develops over the course of a lesson
- Consider personalized learning at the lesson level and/or task level

See this Learning Design Principle:
Assessment & Evidence-Centered Design
Objective Design

Knowledge and skills personalization

Learning experiences that are personalized to learners' knowledge and skills are more efficient and effective than learning that is not.
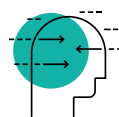
What it feels like for learners

> *I can't do this easily, but I will be able to figure it out with hints and support.*

See this Learning Design Principle: Assessment & Evidence-Centered Design

See this Learning Design Principle: Desirable Difficulty & Scaffolding

- **Knowledge and skills personalization is highly effective when done right**
  Many meta-analyses have found that personalization based on knowledge level leads to strong, positive effect sizes across different age groups, learning systems, domains, and comparison conditions.

- **Personalize to provide the support they need, and take it away when they don't**
  Learners who do not need no support learn less when it is provided. Support should be adaptively reduced as learners progress.

- **Knowledge and skills personalization requires us to model learners' knowledge**
  Learners' knowledge is not static; it changes as they learn. We should go beyond pre-tests and use models that track what learners know as they progress so we can increase and decrease the level of challenge accordingly.

What it means for designing learning experiences

- Assess learners' prior knowledge and experience
- Provide learning experiences that are appropriately challenging, and provide support when needed
- Include ongoing formative assessment
- Consider personalizing learning based on common misconceptions
- Create domain and learner models to identify what level learners are at and what content is appropriate
- When modeling learners' knowledge, acknowledge that understanding develops over the course of a lesson

Interest personalization

Learning experiences that are personalized to learners' interests can support greater motivation and learning.

What it feels like for learners

I am interested — and my knowledge about the topic might help me think about the problem.

- **Interests can provide helpful context**
  Interesting contexts can provide concrete grounding for abstract concepts, creating more ways of accessing and understanding new content.
- **Interests can develop and lead to learning gains**
  Interests can be pre-existing (individual), or sparked by a situation (situational).
  - **Individual interest** is enduring and often carries with it positive feelings, stored knowledge, and personal value. Individual interest typically emerges after repeated experiences of situational interest.
  - **Situational interest** is sparked by the learning environment or features of the content and can fade quickly. Situational interest can be developed into a sustained Individual interest over time with repeated and varied exposure. Personalization can lead to sustained individual interest.

- **Interest personalization should be based on self-identified interests**
  Interest personalization should be driven by the interests that learners themselves identify, not by assumptions based on their identities. Personalization that builds on stereotypes can be harmful to learners' engagement and motivation as well as their identities and agency.

What it means for designing learning experiences

- Base interest personalization on learners' self-identified interests and not on assumptions
- Contextualize the learning content to the learner's pre-existing interests in a light-touch, superficial way
- Transition from situational to sustained individual interest through repeated and novel exposure
- Cultivate sustained interest in a domain through repeated learning experiences superficially personalized to learners' interests
- Consider deeper personalization only if the learners' interests are also specific and deep

Caution around learning styles

Personalizing content to match learning styles does not support learning or motivation.

The term "learning style" refers to the popular but unsupported idea that different people learn best in different ways, and that learning is most efficient and effective when learning environments are personalized to match each learner's learning style.

What it feels like for learners

> *I think I'm an auditory learner, but that does not mean I will learn more from an audiobook than an e-text.*

- **No rigorous evidence for learning styles**
  There is relatively little rigorous research that finds benefits of personalizing learning based on learning styles. In fact, most studies do not find a learning benefit from this form of personalization. At best, matching instruction to learning styles or preferences does not affect learning; at worst, it hurts learning.
- **Priority for better researched principles**
  Basing learning experiences on learning science principles, rather than the neuro-myth of learning styles, is more likely to optimize learning outcomes for all learners. Using less effective

methods of instruction because of a learner's preferred learning style could be detrimental. Instead, choose stronger learning science principles to design around.

See this Learning Design Principle:
Motivation & Mindset
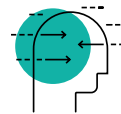
See this Learning Design Principle:
Active Learning, Memory & Practice

What it means for designing learning experiences

- Avoid trying to measure meaningful learner factors using existing research into learning styles; most measures of learning styles have poor reliability and validity and are likely not effective for measuring meaningful learner factors
- Avoid personalization based on learning styles
- Choose better supported learning principles to guide instruction
  - There is limited high-quality empirical evidence investigating the effects of personalizing learning experiences based on learning styles.
  - What evidence there is generally shows no benefits to learning outcomes.

Research-supported personalization factors

Personalizing content according to non-cognitive factors, such as affective states and identity, can sometimes improve learning.

What it feels like for learners

I still learn something even when I go in feeling down or distracted.

Many factors can potentially be used to personalize learning experiences. The three supported by the most rigorous empirical research are:

- **Learner affect:** Learning systems can detect and respond to affective states like boredom, confusion, or frustration, but results have been mixed, with no clear indication that particular learners benefit more.
- **Gaming the system:** This is when learners take advantage of a learning environment to reach correct answers without engaging cognitively with the content. Personalization can be used to shift learners out of this behavior.
- **Identity:** While there is potential for personalization based on identities or experiences, there currently is very little rigorous empirical evidence testing the value of this.

What it means for designing learning experiences

- Determine methods to detect the personalization factor (e.g. affect or gaming)
- Consider personalization based on affective states, e.g.:
  - personalize to boredom by providing prompts to pay attention
  - personalize to confusion or frustration by providing supportive and empathetic messages
- If gaming is detected, provide suggestions to learners to slow down, or reminders that gaming does not help real learning
- Do more research when considering other personalization factors
- Monitor learner perceptions along with learning gains to ensure overall effectiveness
- Validate effectiveness with careful early-stage research and user testing

Guided choice

Providing learners with guided choice in their learning experience can enhance motivation, autonomy, and self-directed learning.

What it feels like for learners

> *I feel in control of my learning through the choices I am making, but I have guidance to make effective choices.*

Choice can increase learners' motivation and performance. However, while many students like having choices, others report higher stress or feeling overwhelmed by academic choice, and learners are often not accurate judges of what they know or what learning practices will be best for them. To reduce these negative effects, provide information to guide learners' choices.

- **Progress information can help learners make instructionally effective choices**
  One study found students learned better with an intelligent tutoring system that let them choose problems, but only when the system provided guidance on what problems to choose based on the students' progress.

- **When allowed to choose when to ask for help, learners may request help too often or not often enough**
  An adaptive system that provided feedback about this behavior led to learners being more likely to request help only when it was appropriate.

- **Choice can be beneficial for all learners; but if a learner makes unproductive choices, it can disrupt other effective learning processes**
  To avoid unproductive choices, make choices educationally irrelevant; or when choices are educationally relevant, provide guidance to help learners make productive choices.

  - **Educationally irrelevant choices (e.g., naming a character)**
    Better for learning, because the learner gets the motivational benefits of making a choice, but still get the most effective learning experience, as determined by the system.
  - **Educationally relevant choices (e.g., deciding which problem to tackle next)**
    Less good for learning, because although learner gets the motivational benefits of making a choice, they may choose a problem that is too easy or too hard, resulting in less effective use of learning time.

See this Learning Design Principle:
Self-Regulated Learning & Metacognition

See this Learning Design Principle:
Motivation & Mindset

What it means for designing learning experiences

- Provide superficial, educationally irrelevant choices
- If you provide instructionally relevant choices, provide learners with guidance to help them make productive decisions and avoid feeling overwhelmed

  - Provide progress information and guidance on different options
  - Make it easy to seek help

- Instructionally relevant choices can build students' self-regulated learning skills and help them make better choices even once the support is removed

Authors

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Elizabeth Richey received her PhD in cognitive psychology from the University of Pittsburgh and has worked as a professor, researcher, and pedagogical coach. As a researcher and educator, she builds connections between research and practice in the areas of learning and motivation. Her research focuses on educational technology, motivation, example-based learning, explanation, collaboration, and belonging. Through laboratory experiments and classroom studies, she examines cognitive, metacognitive, and motivational factors that influence math and science learning from elementary school through college.

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Katherine McEldoon is a research-to-practice connector. After earning her Ph.D. in cognitive and learning sciences at Vanderbilt University and a post at Arizona State University's Learning Sciences Institute, she has worked in academia, government, and industry to ensure the best scientific insights support student learning, no matter the context. Katherine has most recently worked as Lead Learning Scientist on Pearson's Efficacy & Learning team, bringing evidence-based insights to Pearson's world of learners.

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Selected references

- Aleven, V., McLaughlin, E. A., Glenn, R. A., & Koedinger, K. R. (2017). Instruction based on adaptive learning technologies. In R. E. Mayer & P. Alexander (Eds.), Handbook of research on learning and instruction (2nd ed., pp. 522-560). New York: Routledge.

- Bernacki, M. L., Greene, M. J., & Lobczowski, N. G. (2021). A Systematic Review of Research on Personalized Learning: Personalized by Whom, to What, How, and for What Purpose(s)? *Educational Psychology Review*, 33(4), 1675–1715.

- DeMink-Carthew, J., & Netcoh, S. (2019). Mixed Feelings about Choice: Exploring Variation in Middle School Student Experiences with Making Choices in a Personalized Learning Project. *RMLE Online*, 42(10), 1–20.

- D'Mello, S., Lehman, B., Sullins, J., Daigle, R., Combs, R., Vogt, K., Perkins, L., & Graesser, A. (2010). A Time for Emoting: When Affect-Sensitivity Is and Isn't Effective at Promoting Deep Learning. In V. Aleven, J. Kay, & J. Mostow (Eds.), *Intelligent Tutoring Systems* (pp. 245–254). Springer.

- Hidi, S., & Renninger, K. A. (2006). The Four-Phase Model of Interest Development. *Educational Psychologist*, 41(2), 111–127.

- Kirschner, P. A. (2017). Stop propagating the learning styles myth. *Computers & Education*, 106, 166–171.

- Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest*, 9(3), 105–119.

- Steenbergen-Hu, S., & Cooper, H. (2014). A meta-analysis of the effectiveness of intelligent tutoring systems on college students' academic learning. *Journal of Educational Psychology*, 106(2), 331–347.

- Vanbecelaere, S., Van den Berghe, K., Cornillie, F., Sasanguie, D., Reynvoet, B., & Depaepe, F. (2020). The effectiveness of adaptive versus non-adaptive learning with digital educational games. *Journal of Computer Assisted Learning*, 36(4), 502–513.

- Vandewaetere, M., Desmet, P., & Clarebout, G. (2011). The contribution of learner characteristics in the development of computer-based adaptive learning environments. *Computers in Human Behavior*, 27(1), 118–130.

- Walkington, C. A. (2013). Using adaptive learning technologies to personalize instruction to student interests: The impact of relevant contexts on performance and learning outcomes. *Journal of Educational Psychology*, 105(4), 932–945.

- Zhang, L., Basham, J. D., & Yang, S. (2020). Understanding the implementation of personalized learning: A research synthesis. *Educational Research Review*, 31, 100339.